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Local mass transfer from a circular cylinder in a uniform shear flow

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Abstract—A naphthalene sublimation technique is used to investigate the rate of mass transfer from a circular cylinder in a turbulent uniform shear flow. The rate of shear and the mean flow Reynolds number are varied to study their effects on the mass transfer. It is found that the distribution of the local mass transfer rate on the circular cylinder is characterized by a shear parameter K_d, defined as $S \cdot d/U_c$ where S is the shear rate, d the cylinder diameter and U_c the centreline mean velocity. The angular position at which the Sherwood number is minimum is approximately proportional to K_d on both the upper and the lower surfaces of the cylinder. The overall mass transfer rate is largely independent of K_d for the range of the present measurements $0 < K_d < 0.132$, but it is strongly dependent on the centreline mean Reynolds number.

INTRODUCTION

A LARGE number of experiments have been carried out on the heat and mass transfer from a circular cylinder. However, most of those have been concerned with the case where the cylinder is exposed to a uniform cross flow, and the heat and mass transfer characteristics from a circular cylinder subjected to a cross flow of uniform shear has not yet been dealt with.

Sogin and Subramanian [1] measured the local mass transfer from a circular cylinder in a uniform cross flow, and the results were compared with the approximate boundary layer calculation in the laminar region. They found that the calculations were reliable in the region between the stagnation point and the point of separation. Kestin and Wood [2] investigated the influence of free stream turbulence on the mass transfer from a circular cylinder using paradichlorobenzene (p-$C_6H_4Cl_2$). In recent years, experimental investigations on various convection-dominated mass transfer have been conducted by using a naphthalene sublimation technique. Goldstein and Karni [3] examined the effect of the wall boundary layer on the local mass transfer from a circular cylinder. Mayle and Marziale [4] studied spanwise variations of mass transfer from a portion of a cylinder due to turbulence non-uniformity in the mainstream. Van Dresar and Mayle [5] investigated the convection rate at the base of the cylinder due to a horseshoe vortex, and reported a large spanwise variation in the mass transfer within the distance of one incident bounday layer height from the base surface. Goldstein *et al.* [6] carried out an experiment to measure the mass transfer from a square cylinder in a cross flow and from the surface on which the cylinder is mounted. They asserted that the variation of either the Reynolds number or the boundary layer thickness did not change the location of peaks created by the horseshoe vortex system, and only the Reynolds number was found to affect the magnitude of the mass transfer rate.

The same naphthalene sublimation technique is employed in the present study to measure the local rate of mass transfer from a circular cylinder immersed in a uniform shear flow. The centreline mean Reynolds number and the mean rate of shear are systematically varied to obtain the shear parameter K_d, which is defined by $S \cdot d/U_c$, in a range from 0.04 to 0.132. The influences of the Reynolds number and of the shear parameter on the mass transfer rate are analysed by processing our experimental data.

For the present study, an experimental facility was needed to generate a homogeneous uniform shear flow. An experimental realization of such homogeneous shear flow was first achieved by Rose [7]. He used a plane grid which consisted of parallel rods of uniform diameter with non-uniform spacing. The purpose of this experiment was to investigate the effects of shear on the development of the structure of turbulence. Since then, a number of similar experiments have been performed, with slightly different forms of the uniform shear generator [8–11]. For the present experiment, a new shear flow generator has been developed. Construction of the shear generator and the development of the velocity field will be described in the following sections.

BASIC EQUATIONS FOR MEASUREMENT OF MASS TRANSFER RATE

According to Fick's fundamental equation of diffusion, the mass flux at the naphthalene surface may be given by

$$\dot{m} = h_m(\rho_{v,w} - \rho_{v,\infty}) \tag{1}$$

NOMENCLATURE

d	cylinder diameter
D_f	diffusion coefficient
h	convective heat transfer coefficient
h_m	convective mass transfer coefficient
H	test section height
k	turbulent kinetic energy
K	thermal conductivity
K_d	dimensionless shear parameter, $S \cdot d/U_c$
K_H	dimensionless shear parameter, $S \cdot H/U_c$
L_{11}	streamwise integral length scale
$\dot{m}$	average mass flux at sensor surface
Nu	Nusselt number, $h \cdot d/K$
P_v	partial pressure
Pr	Prandtl number
R	universal gas constant
Re_c	Reynolds number, $U_c \cdot d/\nu$
S	shear rate
Sc	Schmidt number
Sh	local Sherwood number, $h_m \cdot d/D_f$
$\overline{Sh}$	average Sherwood number
T	temperature
Δt	sublimated depth of naphthalene
U_c	centreline mean velocity
u', v'	r.m.s. velocities in streamwise and transverse directions
x, y, z	downstream, vertical and lateral coordinates.

Greek symbols

β	open area ratio
ε	dissipation rate of turbulent kinetic energy
θ	angle around a circular cylinder measured from the front stagnation point
ν	kinematic viscosity
ρ_s	density of solid naphthalene
$\rho_{v,w}$	naphthalene vapour density at the wall
ρ_∞	naphthalene vapour density at free stream
τ	non-dimensional development time, $(x/U_c) \cdot (\mathrm{d}U/\mathrm{d}y)$
$\Delta\tau$	exposure time.

where h_m is the coefficient of mass transfer and $\rho_{v,w}$ and ρ_∞ denote the naphthalene vapour concentrations at the wall and at the outer free stream, respectively. The free stream vapour concentration outside the boundary layer is evidently zero. The local sublimation mass transfer from the naphthalene surface per unit area and time can be obtained by

$$\dot{m} = \rho_s \cdot \Delta t/\Delta\tau \tag{2}$$

where Δt is the naphthalene thickness lost owing to sublimation in time $\Delta\tau$, and ρ_s the density of naphthalene.

Combining equations (1) and (2), the mass transfer coefficient can be determined from

$$h_m = \rho_s \cdot \Delta t/(\rho_{v,w} \cdot \Delta\tau). \tag{3}$$

It is assumed that the naphthalene vapour is a perfect gas so that $\rho_{v,w} = P_v/(R \cdot T)$. Here, the naphthalene vapour pressure P_v is calculated from the partial pressure at saturation, which can be evaluated from a semi-empirical formula as a function of temperature [6, 12]

$$P_v(T) = \exp(31.49 - 8673/T) \tag{4}$$

where R is the universal gas constant and T the time-averaged absolute temperature. The surface temperature T is obtained at each location on the naphthalene surface by extrapolating the thermocouple readings close to the surface. The local Sherwood number can then be determined from

$$Sh = h_m \cdot d/D_f \tag{5}$$

where D_f is the diffusion coefficient of the naphthalene into air and d the diameter of the circular cylinder.

EXPERIMENTAL APPARATUS AND METHODS

Wind tunnel, shear flow generator and velocity measurements

Experiments have been conducted in an open-circuit blower-type wind tunnel. The wind tunnel was constructed based on the design guide of Mehta and Bradshaw [13]. The air speed at the square test section (450 mm × 450 mm) was varied from 2 to 33 m s^{-1}, and the level of free stream turbulence intensity was less than 0.5% at the exit of contraction. The settling chamber of the wind tunnel contains three sheets of screens (open area ratio, $\beta > 0.6$) and a honeycomb of hexagonal cells. The contraction area ratio was 8.35 : 1, and the shape of contraction was determined by the method of Morel [14].

A shear flow generator was installed at the exit of the contraction nozzle (Fig. 1). In order to produce the desired velocity profile, the flowing duct of the shear generator was divided into ten equally-spaced narrow channels. At the entrance of each channel, a butterfly damper was installed to control the flow rate through each channel. A small streamlined hill was located behind the damper to reduce the recirculatory wake flow. In addition, a circular rod of 8 mm diameter was installed at the exit of each narrow channel to reduce the length scale of turbulence and to improve the two-dimensionality of the uniform shear field.

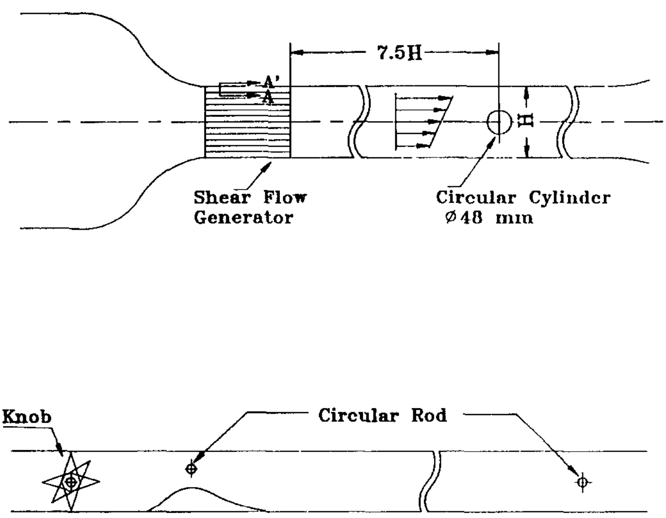

FIG. 1. Arrangement of a shear flow generator and a test circular cylinder in a low speed wind tunnel for mass transfer measurement.

The sidewalls were adjusted divergently in order to compensate for the static pressure loss. When the desired velocity profile was obtained by adjusting the dampers, the uniformity of the shear rate across the test section was checked by using a vertical rake of total pressure probes which were fabricated by 2.12 mm diameter stainless steel tubes. In order to minimize the flow disturbance due to the presence of the probes, the vertical distance between the probes was set at 2 cm, and the distance between the probe hole and the back stem of the rake was 50 tube diameters, as was suggested by Pope and Harper [15].

The measurement of the background turbulent flow field in the test section was carried out by using a two-channel hot-wire anemometer of constant temperature type. The $\times$-wire probe (TSI, model 1241) was made of platinum wire of diameter 6 μm and length 1.25 mm. The wire overheat ratio was 1.5 and the frequency response was set at 15 kHz. The effective inclination of the $\times$-wire to the free stream direction was obtained from the yaw test. Each analogue voltage signal from the two anemometers was digitally sampled by means of an A/D converter and a signal analyser, Data 6000 (Data Precision Model 611), with a data sampling rate of 10 000 s^{-1}.

Casting of naphthalene cylinder and measurement procedure

In order to measure the local rate of mass transfer from the cylinder surface in an approaching shear flow, a thin naphthalene layer was coated on a smooth cylinder surface. The cylinder made of stainless steel consisted of three separable parts, and a recess of about 2 mm deep was machined into the outer surface of the centre part of the test cylinder for the naphthalene casting (Fig. 2). The centre section of the cylinder was coaxially inserted inside the mould, and the molten naphthalene was poured outward into the bottom of the recessed space through two injection holes. In order to separate the mould from the naphthalene-cast cylinder without damaging its surface, the difference of the thermal expansion rates between the aluminium mould and the naphthalene casting was utilized. After a considerable number of trials, it was found that sudden heating of the mould up to about 76°C allows the expansion of the mould only, without transferring heat to the naphthalene. During the casting process, two thermocouples were embedded in the mould and on the surface of the naphthalene cylinder.

A precision roundness measuring instrument (RONOCOM 10A-1) was used to measure the local depth of naphthalene sublimation after exposure to the shear flow. The depth of sublimation was amplified 20 000 times for accurate measurement. Such fine resolution was sufficient to measure the actual change in the naphthalene thickness which varied from about 8.5×10^{-5} to 5×10^{-4} mm min^{-1}. The difference between the initial circumferential shape and the final one represents the amount of the sublimated naphthalene. The naphthalene sublimation is very sensitive to the environmental temperature. Thus, all the measurement procedures were performed in an air-conditioned laboratory in which the temperature was controlled within 0.3–0.5°C variations.

The experimental uncertainty in the present measurement of the local mass transfer h_m given by equation (3) may be assessed according to the uncertainty estimation method described in Holman [16] as follows. The uncertainty in h_m arises from two kinds of errors. One stems from the estimations of the material

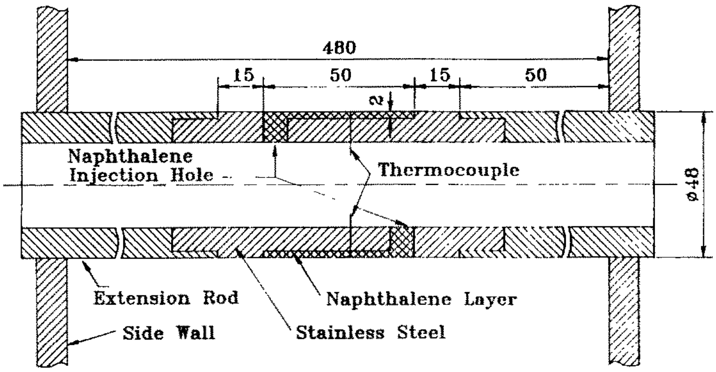

FIG. 2. A schematic view of a naphthalene cast cylinder.

properties and the other is caused by the measurement error. Since the ambient temperature varied during the measurement within 0.5°C, the estimation of the material property, particularly of $\rho_{v,w}$, has an uncertainty of about 5%. This amounts to about 5.2% uncertainty in h_m measurement. The measurement error is mainly due to the resolution limitation of the roundness measuring instrument, which is about 10% of the total sublimation depth for an exposure time of about 100 min. This yields the uncertainty in h_m of about 9.8%. Therefore, the experimental uncertainty in the final evaluation of h_m is approximately 11%, which is comparable to other experiments [17].

RESULTS AND DISCUSSION

The velocity field measurements

Figure 3 exhibits the two-dimensionality of the streamwise mean velocity distribution at $x/H = 7.5$ downstream from the shear generator for various heights y. Far from the boundary layers on the side-walls, the spanwise variation of the mean velocity was small which is comparable to that for other homogeneous flows [8, 9]. Representative vertical profiles of the mean velocity are shown in Fig. 4(a), where U_c is the centreline mean velocity and S the velocity gradient of the shear flow. The boundary layer on the upper plate is thicker than that on the lower one. Aside from these boundary layers, the mean velocity has a nearly uniform shear in the region $0.05 < y/H < 0.88$.

It has been found that, under the same setting of the shear generator resistance, increasing the centreline mean velocity results in the augmentation of the rate of mean shear. However, the mean shear parameter K_H, defined by $K_H = S \cdot H/U_c$, remained constant for these cases. Here, S is the shear rate, H the test section height and U_c the centreline mean

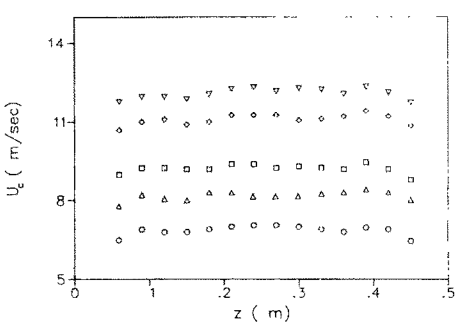

FIG. 3. The horizontal velocity profile at $x/H = 7.0$ and $y/H = 0.5$: ○, $y/H = 0.29$; △, $y/H = 0.42$; □, $y/H = 0.5$; ◇, $y/H = 0.67$; ▽, $y/H = 0.79$.

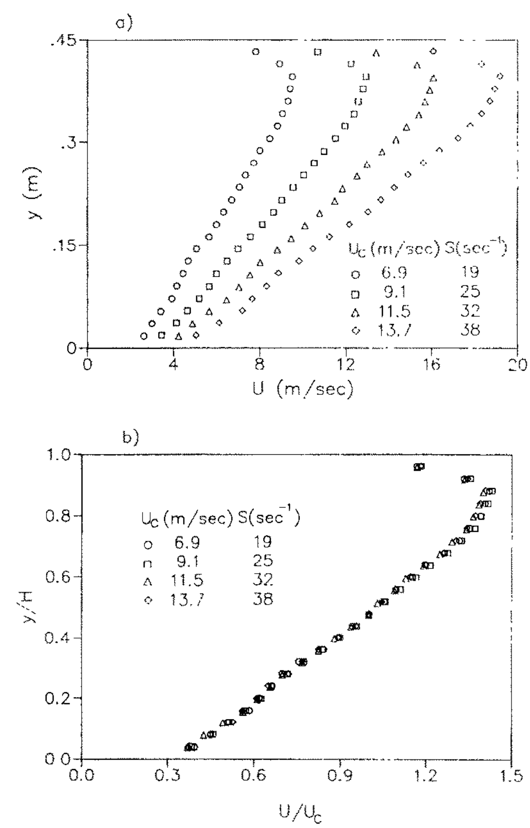

FIG. 4. (a) Mean velocity profiles of shear flows in a wind tunnel at $X = 7.5H$ with different centreline mean velocities under the same setting of the shear flow generator. (b) Similarity plots of the mean velocity distributions in (a).

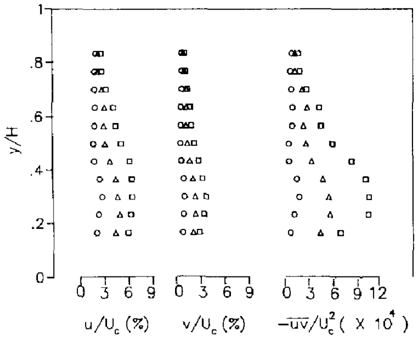

FIG. 5. Transverse variations of the r.m.s. velocities and the Reynolds shear stress at $Re_c = 48\,000$: □, $K_d = 0.132$; △, $K_d = 0.085$; ○, $K_d = 0.040$.

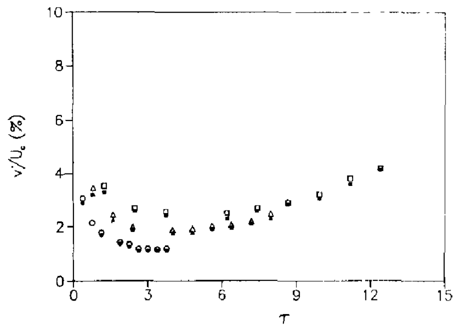

FIG. 7. Downstream development of the transverse r.m.s. velocity. Symbols as in Fig. 6.

velocity. Further, it is noted that such a data set can be collapsed into a single non-dimensional profile by scaling the mean velocity distribution by U_c. Figure 4(b) is obtained in this way, in which the shear parameters K_H are about 1.24.

It has been shown that a perfect homogeneity of the uniform shear flow is, in principle, not realizable [8, 9] and that the homogeneity diminishes with the downstream distance [10]. Transverse variations of the r.m.s. velocities and the Reynolds shear stress at $x/H = 7.0$ are shown in Fig. 5, which reveals that the r.m.s. velocities have better homogeneity than the Reynolds shear stress. The homogeneity of u' and v' in our experiments is comparable to others [9, 10], however, no previous data of the Reynolds shear stress are available for comparison.

The developments of the r.m.s. velocities and the Reynolds shear stress along the centreline of the wind tunnel are shown in Figs. 6–8 for the lowest and highest Reynolds numbers used in the present mass transfer experiments. For the range of the present Reynolds numbers, they are almost independent of Re_d, but strongly dependent on K_d during the initial development time $\tau = (x/U_c)\cdot(dU/dy)$. It may be noted that the downstream variations of all turbulence quantities for lower K_d asymptotically approach to those of their respective quantity for higher K_d. The streamwise integral length scale L_{11} was obtained by

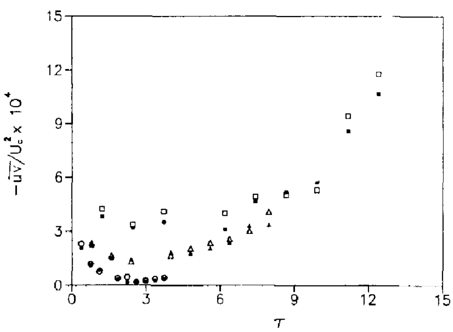

FIG. 8. Downstream development of the Reynolds shear stress. Symbols as in Fig. 6.

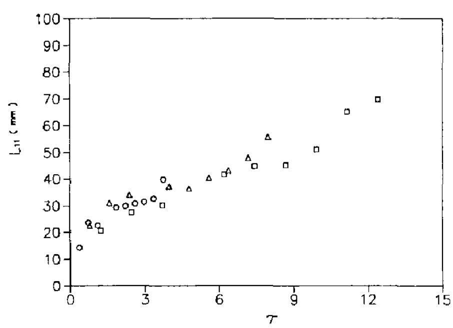

FIG. 9. Downstream growth of the streamwise integral length scale at $Re_c = 48\,000$. Symbols as in Fig. 5.

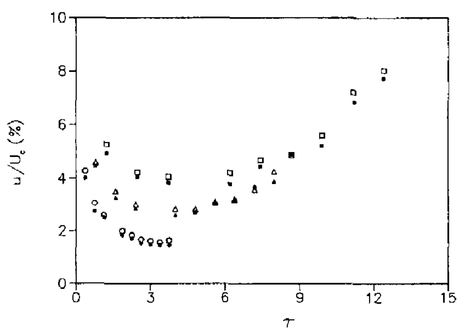

FIG. 6. Downstream development of the streamwise r.m.s. velocity. Symbols as in Fig. 5: solid symbols, $Re_c = 24\,000$; open symbols, $Re_c = 48\,000$.

integrating the corresponding auto-correlation coefficient to its first zero crossing and using Taylor's hypothesis (Fig. 9). Due to a relatively large uncertainty in the length scale measurement by this method as in refs. [8, 10], a strict linearity cannot be observed. However, it shows that the length scale grows monotonically with the downstream distance. All turbulence quantities of interest at the position of the mass transfer measurement $x/H = 7.0$ are summarized in Table 1. Such values for other K_d and Re_d, within the ranges of the present measurements, may be approximately found by interpolations between these data.

Table 1. Background turbulence data for the mass transfer experiments at $x/H = 7.0$ and $y/H = 0.5$

Re_c	K_d	τ	$-\overline{uv}/U_c^2$	k/U_c^2	L_{11} (mm)
	0.040	2.625	1.6992×10^{-5}	1.778×10^{-4}	26.7
24 000	0.085	5.578	2.043×10^{-4}	6.443×10^{-4}	32.3
	0.132	8.663	4.817×10^{-4}	1.438×10^{-3}	37.1
	0.040	2.625	2.5248×10^{-4}	2.091×10^{-4}	30.8
48 000	0.085	5.578	2.361×10^{-4}	6.896×10^{-4}	40.4
	0.132	8.663	5.637×10^{-4}	1.705×10^{-3}	47.7

The mass transfer measurements

The heat transfer coefficient around a circular cylinder at low Reynolds number in a cross flow has a minimum value at the point of separation [12, 18]. As θ increases from zero at the stagnation point, the static pressure on the cylinder surface decreases and the boundary layer thickness gradually increases. These cause a gradual decrease in heat transfer and the minimum point occurs near the point of separation. Then, there is a subsequent increase in the heat transfer coefficient on the rear side of the circular cylinder. However, there are two local minima at higher Reynolds numbers [12, 18]. The first one occurs at the point of transition from the laminar to the turbulent boundary layer and the second at a point from which the turbulent boundary layer is separated. Because of the complicated nature of the flow separation process, it is difficult to calculate the average heat transfer coefficient in a cross flow. A comparison of an approximate boundary layer solution before separation with the present experimental results is shown in Fig. 10. The dotted line corresponds to Frossling's theoretical solution for the laminar boundary layer on a circular cylinder. Here, the heat transfer rates were converted into mass transfer rates by using an appropriate analogy between heat and mass transfers. Direct comparison of the theory for uniform flow with the experimental result in uniform shear flow is not appropriate; however, it can be stated that the local rate of mass transfer around the upper and lower circular cylinder in the uniform turbulent shear flow is higher than that in the uniform laminar flow.

If the approaching flow is uniform ($K_d = 0$) for $Re_c < 10^5$, the local mass transfer coefficient has a minimum value near 80° from the front stagnation point [6, 18]. However, in the mean shear flow, the angle corresponding to the minimum Sherwood number is near 85° on the upper surface and near 75° on the lower surface of the circular cylinder, as shown in Fig. 10. The decreasing rate of *Sh* along the angle from the front stagnation point on the upper surface is found to be slower than that on the lower one.

The variations of the local mass transfer at a fixed shear parameter, $K_d = 0.132$ for different Reynolds numbers on the upper and lower surfaces are shown in Figs. 11(a) and (b), respectively. It can be seen that the qualitative variation of the Sherwood number with

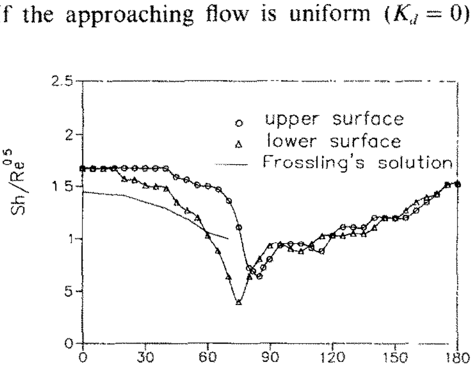

FIG. 10. Local rate of mass transfer around a circular cylinder in a uniform shear flow at $Re_c = 48\,000$ and $K_d = 0.132$.

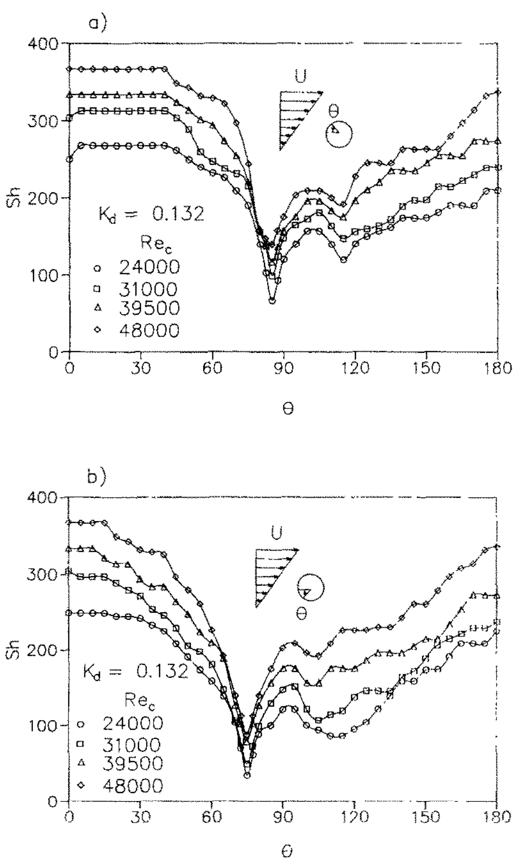

FIG. 11. Variations of the local rates of mass transfer around a circular cylinder with different Re_c at $K_d = 0.132$: (a) upper cylinder surface; (b) lower cylinder surface.

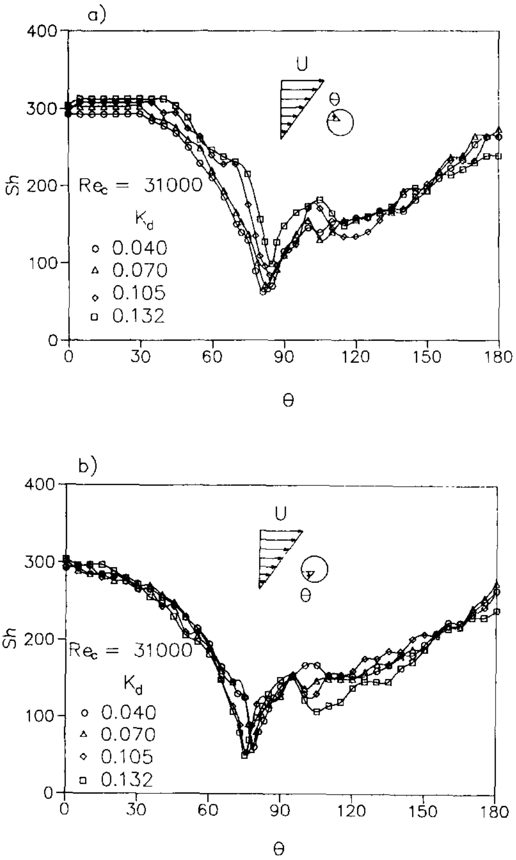

FIG. 12. Variations of the local rates of mass transfer with different K_d at $Re_c = 31\,000$: (a) upper cylinder surface; (b) lower cylinder surface.

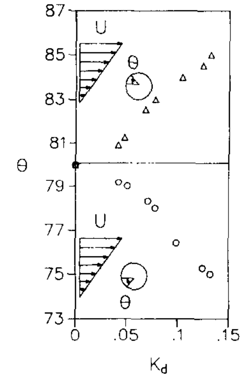

FIG. 13. Dependence of the angular position of minimum Sherwood number on K_d.

θ has a rather consistent shape with a fixed shear parameter even though the Reynolds number and the shear rate vary.

Although the local Sherwood number is a function of Re_c, the minimum of the local Sh occurs at nearly the same location for different shear rates and Reynolds numbers. It is also noted that the local Sh after the separation point first reaches its local maximum and minimum and then gradually increases with θ on both the upper and lower surfaces.

The variation of the local Sh with different values of K_d at a fixed Re_c on the upper and the lower surfaces are shown in Figs. 12(a) and (b), respectively. Comparing this variation with that in Figs. 11(a) and (b), it is concluded that the effect of K_d on the Sherwood number is much weaker than that of Re_c. Before the separation point, the local Sherwood number is slightly higher for higher K_d on the upper surface. (However, there is no such similar relation between Sh and K_d on the lower surface.) Recalling that the increase of the free stream turbulence intensity results in the augmentation of the local heat and mass transfers over a circular cylinder in a uniform cross flow as observed by Kestin and Wood [2] and Lowery and Vachon [19], the dependency of Sh on K_d in Figs. 12(a) and (b) seems to be more attributed to the difference in the intensity of free stream turbulence (see Figs. 6 and 7 and Table 1). Figure 13 shows the positions of minimum Sh as a function of K_d. Increase of the shear parameter causes a gradual delay of the minimum position of Sh in the upper part, while it pulls up the minimum position in the lower part.

In order to investigate the effect of Reynolds number around a circular cylinder on the average Sherwood number $\overline{Sh}$, a circumferential average Sherwood number is determined from the local measurements by

$$\overline{Sh} = \frac{1}{360}\sum_{i=1}^{n} Sh_i \cdot \Delta\theta_i$$

where the increment in degrees ($\Delta\theta$) is an appropriate division of the measured angle in the circumferential direction. The results are shown in Fig. 14, which reveals that $\overline{Sh}$ depends strongly on Re_c but it does not show any consistent dependency on K_d. If the well-known power law $\overline{Sh} = a \cdot Re_c^m$ is applied to these data, the index m turns out to be about 0.6 which is a little higher than that of Zukauskas [18] for the mean heat transfer rate over the circular cylinder in a uniform cross flow.

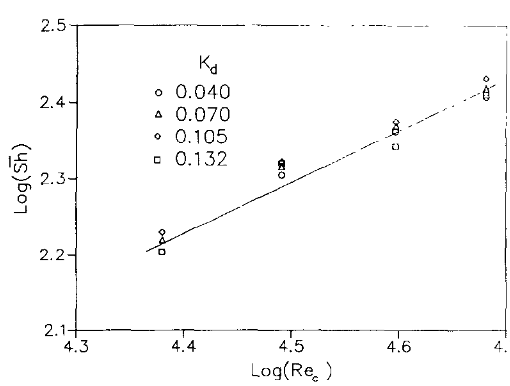

FIG. 14. Dependence of the average Sherwood number on Re_c and K_d.

CONCLUDING REMARKS

A naphthalene sublimation technique was employed to measure the local mass transfer rate around a circular cylinder in cross flow of uniform mean shear. The experiments have been performed in the ranges of $0 \leqslant K_d \leqslant 1.238$ and $24\,000 \leqslant Re_c \leqslant 48\,000$, where Re_c is the centreline mean Reynolds number.

In this range of Re_c, the angular positions of minimum Sherwood number on the upper cylindrical surface and on the lower one do not exhibit much dependence on Re_c, but they vary almost linearly with the shear parameter K_d; an increase in K_d delays the upper position while it pulls up the lower one.

The magnitude of the local Sherwood number, however, strongly depends on Re_c. The weak dependency of the local Sherwood number on K_d observed in the present measurements may be due to the difference in intensity of free stream turbulence for different K_d.

The average Sherwood number around the circular cylinder also depends strongly on Re_c, but the dependence on K_d is minor. If the power law $\bar{Sh} \sim Re_c^m$ is assumed, the index m turns out to be about 0.6, which is a little higher than that of the power law correlation of the heat transfer around the circular cylinder in a uniform cross flow.

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TRANSFERT LOCAL DE MASSE A PARTIR D'UN CYLINDRE DANS UN ECOULEMENT

Résumé—Une technique de sublimation de naphtalène est utilisée pour étudier le flux de masse convecté à partir d'un cylindre circulaire dans un écoulement turbulent de cisaillement. Le taux de cisaillement et le nombre de Reynolds de l'écoulement moyen sont variés pour étudier leurs effets sur le transfert de masse. On trouve que la distribution du coefficient local de transfert autour du cylindre est caractérisée par un paramètre de cisaillement K_d défini par $S \cdot d/U_c$ où S est le taux de cisaillement, d le diamètre du cylindre et U_c la vitesse moyenne au plan central. La position angulaire pour laquelle le nombre de Sherwood est minimal est approximativement proportionnelle à K_d à la fois sur les surfaces supérieure et inférieure du cylindre. Le coefficient global de transfert de masse est largement indépendant de K_d dans le domaine des mesures effectuées $0 < K_d < 0{,}132$, mais il est fortement dépendant du nombre de Reynolds sur le plan central.

ÖRTLICHER STOFFÜBERGANG AN EINEM KREISZYLINDER IN EINER GLEICHFÖRMIGEN SCHERSTRÖMUNG

Zusammenfassung—Mit Hilfe der Naphtalinsublimationstechnik wird der Stoffübergang an einem Kreiszylinder in einer gleichförmigen turbulenten Scherströmung untersucht. Die Schubspannung und die mittlere Reynolds-Zahl der Strömung werden variiert, um den Einfluß auf den Stoffübergang zu untersuchen. Dabei zeigt sich, daß die örtliche Verteilung des Stoffübergangs am Kreiszylinder mit einem Parameter für die Schubspannung K_d beschrieben werden kann. Dieser ist definiert als $S \cdot d/U_c$, wobei S die Schergeschwindigkeit, d der Zylinderdurchmesser und U_c die mittlere Geschwindigkeit in der Strömungsachse ist. Die Stelle am Rohrumfang, an der die Sherwood-Zahl am kleinsten ist, verhält sich näherungsweise proportional zu K_d. Dies gilt sowohl für die obere wie auch die untere Oberfläche des Zylinders. Der Gesamtstoffübergang ist weitgehend unabhängig von K_d (gültig für $0 < K_d < 0{,}132$ bei den vorgestellten Messungen), er hängt jedoch stark von der mittleren Reynolds-Zahl im Kern der Strömung ab.

ЛОКАЛЬНЫЙ МАССОПЕРЕНОС ОТ ЦИЛИНДРА КРУГЛОГО СЕЧЕНИЯ В ОДНОРОДНОМ СДВИГОВОМ ТЕЧЕНИИ

Аннотация—Метод сублимации нафталина используется для исследования скорости массопереноса от цилиндра круглого сечения в турбулентном однородном сдвиговом течении. Скорость сдвига и среднее число Рейнольдса для течения варьируются с целью установления их влияния на массоперенос. Найдено, что распределение скорости локального массопереноса на цилиндре круглого сечения характеризуется параметром сдвига K_d, определяемым как $S \cdot d/U_c$, где S—скорость сдвига, d—диаметр цилиндра, а U_c—средняя по оси скорость. Угловое положение, при котором значение числа Шервуда минимально, приблизительно пропорционально K_d как на верхней, так и на нижней поверхностях цилиндра. Общая скорость массопереноса слабо зависит от K_d в диапазоне измерений $0 < K_d < 0{,}132$, но сильно зависит от среднего по оси числа Рейнольдса.